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ABSTRACTS FROM ASTRONOMICAL PUBLICATIONS.

In accordance with a recent arrangement the members of the scientific staff of the Lick Observatory hold meetings once per week, as an observatory duty, to report upon and discuss the more important articles appearing in the journals of astronomy, the important new books on astronomical subjects, or subjects of current and special interest in the observatory's work. It has been suggested that abstracts of the reports would be of interest to the readers of these Publications, and the Publication Committee has acted favorably upon the suggestion.

It is intended to preserve the qualities of abstracts as far as possible, and to restrict published criticisms, favorable or unfavorable, to a minimum.

REVIEW: "THE SUN," BY CHARLES G. ABBOT, S. M., DIRECTOR
SMITHSONIAN ASTROPHYSICAL OBSERVATORY.¹

The book represents an effort on the part of Mr. ABBOT to give in popular form a general account of our present-day knowledge of the Sun, solar radiation, and phenomena more or less closely connected therewith. In view of the brilliant results which have rewarded the efforts of investigators of solar phenomena during recent years and the lack of any authoritative treatise on the subject, in the English language at least, the work is particularly welcome, and astronomers are to be congratulated that the work of collecting and arranging the material has been undertaken by the able hands of the brilliant author who has contributed so largely to the advance of our knowledge of the subject.

The scope of the work is rather wide, including such a diversity of topics as the determination of the solar parallax, the classification of stellar spectra, and the chemical composition of foods. A very fair idea of the ground covered may be obtained from a perusal of the chapter headings, which are as follows:—

I. The Solar System—The Sun's Distance—Its Dimensions	Pages	1-30
II. The Instruments and Methods Used in Solar Investigation	"	31-84
III. The Photosphere	"	85-127
IV. Eclipses and the Outer Solar Envelopes	"	128-182

¹ Published by D. Appleton & Co., New York and London. 1911. Illustrated. \$2.50 net.

V. Sun-Spots, Faculæ and Granulation	"	183-214
VI. What Is the Sun?	"	215-279
VII. The Sun as the Earth's Source of Heat	"	280-330
VIII. The Sun's Influence on Plant Life	"	331-361
IX. Utilizing Solar Energy	"	362-390
X. The Sun Among the Stars	"	391-434

There is also a Conclusion and an Index.

The portions of the book of greatest interest to the professional astronomer are naturally those which treat of the phases of the solar problem with which the work of the author has been most closely identified—that is, the measurement of the so-called "solar constant," a term, by the way, which his activities have proved to be a misnomer. Much of the material has only recently become available to astronomical readers, and the book contains summaries of some of the author's most interesting and important results. Among these may be mentioned the discovery of the variability in the amount of the solar radiation. An excellent feature of the treatment is found in the free use of curves, and some of these which give the intensity of radiation as a function of latitude, season and hour angle are particularly illuminating. But space will not permit a reference to more than a fraction of what is interesting and important in the great work which is being carried on by the Smithsonian Institution, and which, aside from its purely scientific interest, touches so closely the conditions which make for the existence of life upon the Earth.

Under the caption "What is the Sun?" is given a résumé of the principal theories that have been advanced as to the constitution of this body, followed by an account of the author's views. This account forms one of the features of the book. The fundamental assumption in the theory adopted by the author is that of a gaseous Sun, into which it is impossible to see to any great depth on account of the scattering of light by the molecules of the gas. The necessity of assuming a gaseous origin of radiation the author finds in the apparent inability of any known substance to remain solid or liquid at the temperature which his researches show to exist at the seat of solar radiation—i. e. about 6,000° absolute Centigrade. As to the transparency of such a Sun, he finds, basing a calculation on

the researches of RAYLEIGH, SCHUSTER, and others, that it would be impossible to see more than 5,000 miles vertically downward into its interior. At the limb of the Sun the depth would of course be less, probably under 500 miles. Such a distance, compared with the diameter of the Sun, would of course be negligible, so that the gaseous ball would present the appearance of a solid disk with a sharp boundary. The continuous spectrum is accounted to result from the pressure at the point or region where the effective radiation originates, since laboratory experiments show that a gas under pressure may give a continuous spectrum, or even a continuous spectrum with dark lines. For a detailed account of the theory, considered in connection with numerous phenomena presented by the solar surface, the reader must be referred to the book. Mr. ABBOT's treatment is rather extended, and, to the reviewer, not convincing in all of its phases. The subject is one of great complexity and in many cases, particularly in the consideration of phenomena presented at the edge of the Sun, the forming of an idea of just what would occur as a result of the assumed conditions would seem to require a more rigorous analysis than the author has found it expedient to give. It may be that a more complete discussion is barred by the popular form in which the work is cast, and this raises, once more, the question as to the wisdom of attempting to discuss in popular or elementary books theories and phases of theories that have not had the benefit of extended criticism by those qualified to judge and discuss them.

The strong points of Mr. ABBOT's hypothesis are those which have been referred to, i. e.—

1. The temperature of the Sun at the origin of effective radiation is so high that no known substance can withstand vaporization.
2. The hypothesis is competent to explain the solid appearance of the Sun and its sharp boundary.
3. The theory leads to no contradiction of the observed character of the solar spectrum—that is, a continuous spectrum crossed by dark lines.

It would seem to be preferable in a work of this character to rest upon these three considerations, rather than to try to

strengthen its position by the somewhat uncertain props of a necessarily inexact analysis of the results of exceedingly refined observations. In fact, one of the few features of this admirable book which it is possible to criticise adversely is found in the effort which has been made to present what is in reality a complex subject in such a form as to be readily assimilable by a reader quite unfamiliar with the most elementary conceptions of physical science. It is doubtful whether it is possible to do this with success, and the author has, in fact, been unable to carry out the idea consistently. To illustrate, we quote from chapter I, page 29:—

From these figures the mass . . . of the Sun is 4.38×10^{30} pounds, or 1.990×10^{30} kilograms (that is 4, or 1, followed by 30 places of zeros).

In chapter II, without any further enlightenment as to the nature of an exponent, we are introduced to the WIEN-PLANCK radiation formula:—

$$e = c_1 \lambda^{-5} (\epsilon^{\frac{c_2}{\lambda T}} - 1)^{-1}$$

Again, after discussing many theories of radiation, and the distribution of energy in the solar spectrum, we are informed in one of the later chapters that light “is not a material substance, but waves, similar in some respects to waves which travel on water, or on a stretched rope.” (Page 283.) It seems doubtful whether it is worth while, or in fact desirable, to discuss unsettled questions properly belonging on the frontier of science for the benefit of persons unfamiliar with the exponential notation or such conceptions as those involved in the elements of the wave theory of light.

As has been indicated, the book covers a wide range, and the author has allowed himself abundant latitude in marking the boundaries of his field, but all the material chosen has been unified by his happy treatment. The chapters on the Sun’s influence on plant life and on the direct utilization of solar energy are entertaining and suggestive, and contain much matter not accessible to the average astronomer.

Errors seem to be comparatively few, a comment it is unfortunately not always possible to make in connection with

books purporting to offer the latest thing in the product of scientific workshops. It is, however, perhaps too much to expect perfection in this respect. On page 260 there is a note on the explanation by which W. A. MICHELSON accounts for the apparently great velocities in the line of sight by assuming more moderate ones across this line. As no direct reference is given to any publication by MICHELSON, it is not possible to fix definitely the responsibility for this interpretation of his views. The reviewer is, however, not familiar with any of that investigator's articles which would warrant the text and figure under discussion. Whatever the origin of the idea, it is misleading, since it is evident that a spectroscopic determination of the cloud depicted in the figure would give its true radial velocity.

We may be permitted to repeat that the book is unusually accurate. It is crowded from cover to cover with data of the greatest interest, and the lump which might have resulted from a less skillful handling of the material is leavened by a singularly happy faculty of expression. The work should be in the library of every one interested in solar physics.

W. H. WRIGHT.

HYPOTHETICAL PARALLAXES OF THE BRIGHTER STARS OF
CLASS A.

Under the above title Mr. H. C. PLUMMER, of the Oxford Observatory (formerly Fellow in the Lick Observatory), presented a paper at the January meeting of the Royal Astronomical Society, of which an abstract is published in the *Monthly Notices* of the society.

This investigation is based upon the radial velocities of 172 Class A stars which I had forwarded in manuscript to Mr. PLUMMER early in June, 1911. Professor BOSS had a short time previously found for the Class A stars that the components of proper motions which are at right angles to the great circles joining the stars with the apex of solar motion appear to increase as the galactic latitudes of the stars increase, and I had found simultaneously and independently that the radial velocities of these stars decrease with increasing galactic latitudes. To some extent these results would follow if the stars of Class

A have strong preferences for motions toward the two points known as KAPTEYN'S vertices of preferential motion, inasmuch as these vertices are not very far from the plane of the Milky Way. However, a hasty and preliminary tabulation of the radial velocities, with reference both to KAPTEYN'S vertices and to the poles of the Milky Way, convinced me that there must be a preference of the brighter Class A stars for motion in planes parallel to the Milky Way, essentially independent of any existing preference for KAPTEYN'S vertices. I had further found from a comprehensive study of the Class B radial velocities that stars of this class appear to have no preferential motion toward KAPTEYN'S vertices; but as our radial velocities of *all* classes of stars exhibited a slight preference for these vertices, that the preference probably first developed and showed itself in the Class A group.

As I was leaving the observatory for several months, I suggested to Mr. PLUMMER that it would be well to make a comprehensive investigation of the motions of the Class A stars, to determine among other matters just where in the spectral classification the KAPTEYN preferential motion appeared to enter, using also the Class B velocities for this purpose if desirable.

Thus far Mr. PLUMMER has studied the Class A radial velocities, utilizing of course the known proper motions of the same stars, on the assumption that the stars are actually moving parallel to the plane of the Milky Way.

I had found that the average radial velocities of the Class A stars lying within 30° of the plane of the Milky Way, within the zones 30° to 60° from the plane of the Milky Way, and within the zones 60° to 90° from the plane of the Milky Way, gave the results in the first line of the following table:—

RADIAL VELOCITIES OF THE BRIGHTER CLASS A STARS IN TERMS OF GALACTIC LATITUDES.

$0^\circ - \pm 30^\circ$		$\pm 30^\circ - \pm 60^\circ$		$\pm 60^\circ - \pm 90^\circ$		Authority
No. of stars	Veloc. km.	No. of stars	Veloc. km.	No. of stars	Veloc. km.	
98	13.0	61	9.2	18	5.6	CAMPBELL, observed
98	13.0	72	9.7	26	4.6	PLUMMER, computed

Mr. PLUMMER found that if we suppose the stars to be scattered uniformly over the celestial sphere and moving strictly

parallel to the plane of the Milky Way, we should have the numbers of stars and the average velocities in the same zones as in the second line of the table. As a starting-point, he had assumed the same number of stars, ninety-eight, and the same average velocity, 13.0^{km} , in the zones nearest the Milky Way. The close accordance of the two lines of data is very striking. Recalling that the Class A stars are more thinly distributed over the celestial sphere as we pass from the galactic plane to the galactic poles, whereas PLUMMER assumed them to be uniformly distributed over the sphere, we see that the agreement is even remarkable.

There were available for the basis of Mr. PLUMMER's investigation the radial velocities and the proper-motion components in right ascension and declination of all the stars on the list. Assuming the solar apex to be at the point whose right ascension is 270° and declination $+30^\circ$, and that the velocity of the solar system is 16.80^{km} , which I had previously derived from the Class A stars, it became possible to write an equation, for each star, involving its known components of motion, with its parallax as the only unknown quantity. The value of the parallax computed from this equation harmonized of course the observed radial motion in kilometers per second and the observed angular proper motion. It then became possible to compute the linear components of each star's motion with reference to rectangular axes passing through the position of the Sun at any instant.

Mr. PLUMMER found for the 172 stars:—

Negative parallaxes	38
Excessive velocities	8
Excessive parallaxes	2
Reasonable parallaxes	124

That so large a proportion of the parallaxes are in harmony with our ideas of stellar distances as derived from other investigations is believed by Mr. PLUMMER to be strongly in support of the view that the Class A stars have a marked preference for motion in planes parallel to the Milky Way.

When the rectangular components of motion were tabulated, the stars for the most part seem to fall into groups of stars

whose resultant motions are equal and along parallel lines. Of particular interest is the fact that several of the stars widely distributed over the surface of the celestial sphere appear to be members of the group (about forty stars) in the *Taurus* region whose motions were found by Professor Boss several years ago to be equal and parallel.

Mr. PLUMMER is careful to insist that we must not regard the results of his investigation as a definite proof that the Class A stars are moving in planes parallel to the central plane of the Milky Way, but only that they have a strong preference for motion in that plane. It may be that none of the stars is moving precisely in such plane, but we can scarcely doubt that a large proportion are moving in planes making reasonably small angles with the Milky Way.

The radial velocity investigations of the past two years have served in various ways to throw light upon the average parallaxes of the brighter stars. In effect, these results have increased our estimates of the scale on which the stellar universe is constructed, and to that extent they have given us fuller appreciation of the difficulties involved in determining the parallaxes of *individual* stars. We are therefore the more prepared to welcome methods of investigating stellar parallaxes and the scale of the universe, such as that used by Mr. PLUMMER.

W. W. CAMPBELL.

ON THE DISTRIBUTION OF BRIGHTNESS IN THE TAIL OF HALLEY'S COMET.

An interesting investigation on this point is given by SCHWARZSCHILD and KRON in the *Astrophysical Journal* for December, 1911. The data for the paper were secured by the expedition from Potsdam Observatory to the island of Teneriffe in the spring of 1910. The apparatus was very simple, consisting solely of two exactly similar Zeiss lenses slightly less than an inch in aperture; the objective of one of these lenses was stopped down so as to diminish the brightness by four-tenths of a magnitude. The main question in the investigation is whether the falling off in the brightness of the tail at distances from the head is due solely to the diminution in density.

whence it would follow that the luminosity of a unit mass in the tail would remain constant during its travels in space, or whether the decrease in brightness is much more rapid than the decrease in tail-density, as might be expected if the tail were self-luminous. Besides the decrease in tail density as it recedes from the head, due to the spreading out and expansion of the tail streamers, another factor must be taken into account, the decrease due to the increase in velocity of the tail particles as they move away from the head. The data for these velocities in the tail were taken from the Lick Observatory results in *Publications of the Astronomical Society of the Pacific*, 22, 125, 1910.

As a result of the investigation it is found that the decrease in the brightness of the comet's tail is for the most part explained by the falling off in density. This would be a natural result of the assumption that the light of comet tails is due to fluorescent or resonance radiation excited by solar radiation.

Perhaps the most interesting results are given at the close of the article with regard to the probable density of the matter forming the tail. From our knowledge that the mass of comets is always so small as to be entirely neglected in calculations it has been possible, in times past, to calculate from the known cubic contents of a large comet tail, an upper limit to the density. It is known from such calculations that the density must be very low, but the present results must be regarded as much more trustworthy. The reasonable assumption is made that the particles in the comet's tail are fluorescent molecules; from many accordant physical investigations it is known that the size of such molecules for the average hydrocarbon gases is of the order of one-millionth of a millimeter. From this it would follow that the mass flowing along the cross-section of the tail per second would be only about one hundred and fifty grams (five ounces), while the density, in terms of the density of air, is infinitesimally small, only four trillionths of a trillionth (the fraction, one, divided by four followed by twenty-four ciphers). The best vacuum obtainable in laboratories is thus trillions of times as dense as a comet's tail. If the Earth were exposed for an entire day to a tail of such density with a velocity of sixty miles per second, the total mass caught by the

Earth in its passage would be a matter of only a few hundred tons, from which it may be seen how little material action is to be expected by a transit through the tail of a comet.

H. D. CURTIS.

In the *Astrophysical Journal* for December, 1911, Professor R. W. WOOD has investigated the use of nickelled glass reflectors for celestial photography. As is well known, silver is a very poor reflector of ultra-violet light, and for investigations in this region of the spectrum it is necessary to use mirrors of speculum metal or MACH's alloy. Such mirrors are expensive and less convenient than mirrors formed by a film of metal on glass. Professor WOOD has developed methods of coating glass mirrors with a film of nickel instead of silver, as ordinarily employed. While the practical results are still somewhat inferior to speculum metal, there will doubtless be many possibilities for the use of such easily made nickel reflectors in physical experiments.

H. D. CURTIS.

A RELATIVITY MODEL.

In the *Physikalische Zeitschrift* for December 15, 1911, Dr. H. ROHMANN gives a description of a model which has been constructed to illustrate visually the principles of the theory of relativity. It consists of easily read dials and scales for a moving system, and a stationary system, so connected by endless steel ribbons running over properly proportioned pulleys that the changes in the units of time and length which are a result of this new theory are indicated on the dials and scales of the moving system.

The model was devised by Dr. E. COHN, and arrangements have been made for its construction and sale at a moderate price.

H. D. CURTIS.

A rather novel direct-vision spectroscope is described by Dr. H. LEHMANN in the *Zeitschrift für Instrumentenkunde* for January, 1912. The ordinary direct-vision spectroscope is provided with a slit, entailing great loss of light, and necessitating quite accurate pointing of the instrument at the source

of light. The new design is slitless, being designed primarily for the observation of a point-source of light. It has thus great light-gathering power, and as the field of view is large, it is very convenient in use. In fact, it is suggested that its main application would be its use in a lecture-room, enabling its possessor to observe the lines of the spectrum of a substance from any point of a large auditorium. Reference to the details of the rather novel design must be sought from the original article; in its essentials, it consists of a cylindrical lens and a train of prisms for direct vision. It is unique in that it has no ocular, the human eye, in effect, being a part of the design of the instrument. A point source of light forms lines in the spectral image thrown on the retina. LEHMANN states that the electric lights as seen from the hills about Jena show excellent line spectra. Astronomically, it would seem that such an instrument might be very convenient in observing meteor spectra, owing to its large field; its form is simply that of a light tube about ten inches in length, making it very easy of manipulation.

H. D. CURTIS.